



**California State Board of Equalization**  
450 N Street, Sacramento, California 95814

**Indoor Air Quality/Odor Assessment**  
**June 2011 – January 2012**  
**Draft Report**

*Project No. 2372.02-572*



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## **1.0 ODOR PROBLEM BACKGROUND**

Facility historical records and discussions with occupants of the Board of Equalization (BOE) building at 450 N Street, Sacramento, California, have indicated the presence of musty odors of unknown origin on the 21<sup>st</sup> floor of the building. From December 11, 2009 through April 1, 2010, the 21<sup>st</sup> floor was turned over to the Department of General Services (DGS) Project Team as part of the building mold remediation project. During this period, multiple measures were taken to identify and eliminate any possible sources of the odors. An extended period of time (greater than that spent on other non-odor floors) was spent in ensuring the floor had been thoroughly investigated and remediated wherever warranted. In April 2010, the floor was returned to the BOE for re-occupancy.

During the ensuing year, complaints of odors appeared to be non-existent. However, in March 2011, the DGS-BOE Project Management Team was notified by BOE Management that on February 24<sup>th</sup>, odors were once more reported on the 21<sup>st</sup> floor. After a discussion between the floor occupants, Hygiene Technologies Inc. (HTI) and LaCroix Davis LLC (LCD), it was discovered that the floor occupants had begun experiencing the musty odors only a short time after re-occupying the floor in April 2010.

On March 4, 2011, Liz Houser, BOE Deputy Director Administration, met with representatives from DGS, HTI, and LCD to discuss the recent odor complaints. It was in Ms. Houser's meeting that an odor investigation of the 21<sup>st</sup> floor was initiated that would eventually include investigations of the indoor air quality (IAQ) in the core interstitial spaces of the building, the building heating, ventilation, and air conditioning (HVAC) systems, and floor coverings in the form of vinyl composite tiles (VCT). The HVAC and VCT related investigations and findings are discussed in separate summary reports. This report addresses the IAQ/odor assessment of the core interstitial spaces of the building.

## **2.0 BUILDING CORE IAQ/ODOR ASSESSMENT**

The assessment was performed under the direction of Mr. Chris Corpuz, LCD Senior Project Manager. Mr. Theodore M. Ice, LCD Senior Associate, and other DGS and HTI personnel, conducted detailed inspections and collected various types of air samples to assess the reported IAQ/odor problem. Unable to identify any apparent sources of odor in areas that are normally accessible to building tenants or BPM personnel, the assessment was expanded to the building core interstitial spaces.

### **2.1 Building Core Sample Port Installation**

In order to identify or eliminate the building core interstitial spaces as potential sources of odor, thirty-one (31) sampling ports were installed to access the main vertical shafts of the building (see Figures 1 and 2). The ports were designed to meet NFPA and California State Fire Marshall inspection scrutiny. The sampling ports were positioned above the hard ceiling in the restrooms or above suspended ceiling tiles in the hallways to allow the use of sample collection equipment without disturbing the normal tenant work spaces.



*Fire-Rated Sampling Port*

## **2.2 Spore Trap Samples**

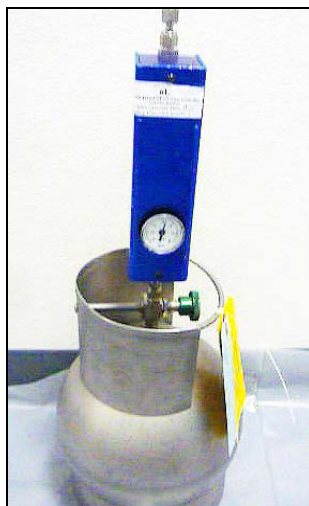
Visible mold growth (VMG) had been previously identified during limited destructive testing in some of the building core interstitial spaces. Therefore, on November 4, 2011, a total of thirty-four (34) spore trap samples were collected, one from each core interstitial space sampling port on Floors 2 and 21, and three (3) exterior background samples. The samples from Floor 2 served as background comparison samples for the samples collected on Floor 21. Each sample was collected at a sampling rate of 15 liters per minute for 5 minutes. The samples were submitted to EMLab P&K (EMLab) of West Sacramento under standard chain-of-custody. The laboratory reports are attached in Appendix A.



*Spore Trap Sampling through Sampling Port*

### **2.3 Volatile Organic Compound (VOC) Samples**

On November 4, 2011, thirty-one (31) volatile organic compound (VOC) core samples were also collected from core interstitial spaces on Floors 2 and 21 for laboratory analysis. The core samples from Floor 2 served as background comparison samples. The air samples were collected in summa canisters (6 liters) for approximately eight hours and analyzed using the EPA Method TO-15 for potential VOC and tentatively identified compounds. LCD employed the services of Environmental Analytical Services, Inc. (EAS) in San Luis Obispo, California, for the VOC core sample analyses. EAS is accredited by the National Environmental Laboratory Accreditation Program (NELAP). The EAS laboratory reports are attached in Appendix B.



*VOC Sample Collection via Summa<sup>®</sup> Canister*

The thirty-one (31) core VOC samples were compared to the VOC samples collected during VCT removal activities between June 2011 and January 2012 from exterior and interior floor areas. The VCT VOC samples were utilized as background comparison for the November core interstitial space samples. They were analyzed by Air Toxics Ltd. in Folsom, California. Air Toxics Ltd. is accredited by the National Environmental Laboratory Accreditation Program (NELAP). The laboratory reports for these samples are included in the VCT Removal Reports and are not attached to this report.

### **2.4 Microbial VOC Samples**

Microbial volatile organic compounds (MVOC) are composed of low molecular weight alcohols, aldehydes, amines, ketones, terpenes, aromatic and chlorinated hydrocarbons, and sulfur-based compounds, all of which are variations of carbon-based molecules. MVOC have a very low odor threshold, making them easily detectable by smell. They often have strong odors and are responsible for the odious smells (often described in terms such as old cheese, dirty socks, or locker room) associated with mold and bacterial growth.

EAS analyzed each of the thirty-one (31) VOC core samples collected on November 4, 2011, in order to determine if any of these samples contained VOC typically produced in situations where specific types of fungi or microbial organisms may be present.

### 3.0 RESULTS OF INVESTIGATION

#### 3.1 Spore Trap Samples

In general, with the exception of three spore trap samples collected from the south-southwest core sample locations, all of the spore trap samples were unremarkable. In some samples, no airborne spores were detected. The spore trap samples collected from core sample locations 21-13, 21-14, and 21-16, showed elevated concentrations of *Penicillium/Aspergillus* (Pen/Asp) type spores. The laboratory reports and chain-of-custody forms from EMLab are provided in Appendix A.

#### 3.2 VOC Samples

The VOC sample results are summarized in Table 1. The laboratory reports and chain-of-custody forms from Environmental Analytical Services, Inc. and Air Toxics Ltd. are provided in Appendix B.

The VOC results were compiled and compared to the following standards and guidelines:

- California Division of Occupational Safety and Health (DOSH) Permissible Exposure Limits (PEL)<sup>1</sup>;
  - California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment (OEHHA) Reference Exposure Levels (REL)<sup>2</sup>;
  - Proposition 65 (Prop 65) Safe Harbor Levels<sup>3</sup>;
  - Various odor thresholds compiled by the American Industrial Hygiene Association (AIHA)<sup>4</sup> and Nagata<sup>5</sup>.
1. No VOC sample results exceeded the applicable California DOSH PELs (8-hour Time-Weighted Average). One VOC (naphthalene) was detected in two samples in levels that exceeded the Cal OEHHA chronic RELs (naphthalene chronic REL: 2 ppb; detected 3.09 ppb in sample #21-12 and 2.83 ppb in sample #21-13). Naphthalene's odor threshold is higher (AIHA minimum odor threshold: 9.5 ppb) than naphthalene concentrations detected in core samples #21-12 (3.09 ppb) and #21-13 (2.83 ppb). Naphthalene was, therefore, not found in detectable odor concentrations.

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<sup>1</sup> California Division of Occupational Safety and Health (DOSH). "Table AC-1, Permissible Exposure Limits (PEL) for Chemical Contaminants." ONLINE. Available: [http://www.dir.ca.gov/Title8/5155table\\_ac1.html](http://www.dir.ca.gov/Title8/5155table_ac1.html) [29 May 2012].

<sup>2</sup> California Environmental Protection Agency (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA). 2012. "OEHHA Acute, 8-hour and Chronic Reference Exposure Levels (chRELs)." ONLINE. Available: <http://oehha.ca.gov/air/allrels.html> [29 May 2012].

<sup>3</sup> California Environmental Protection Agency (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA). "Proposition 65 Safe Harbor Levels, September 2011." ONLINE. Available: <http://www.oehha.ca.gov/prop65/pdf/Sept2011Status.pdf> [29 May 2012].

<sup>4</sup> American Industrial Hygiene Association. 1989. "Odor Thresholds for Chemicals with Established Occupational Health Standards." AIHA: Akron, OH.

<sup>5</sup> Nagata, Y. 2003. "Measurement of odor threshold by triangle odor bag method." *Odor Measurement Review*, Japan Ministry of the Environment 118-127.

2. Two VOC (isobutyl alcohol and toluene) were found in concentrations slightly above the AIHA's minimum odor thresholds of 12 ppb and 21 ppb for the two compounds, respectively.
  - Isobutyl alcohol was detected at 13.41 ppb in sample #2-10
  - Toluene was detected at 23.1 ppb in sample #2-9.
3. No other VOC were detected above either odor threshold criteria (AIHA or Nagata).
4. Several interior VOC concentrations were above the exterior ambient air sample concentrations. Some of the VOC detected indoors were not detected in the ambient exterior air. These concentrations are presented in the Table 1. However, all interior VOC concentrations were multiple orders of magnitude below the California occupational exposure limits (California DOSH PELs).
5. Nineteen (19) VOC that are listed on OEHHA's Prop 65 list were detected in the building. Thirteen (13) of those VOC may exceed the threshold requiring Cal Prop 65 notification, but these core samples were collected in locations inaccessible to personnel. Additional information on VOC concentrations in the building (collected historically) should be evaluated to determine the applicability of the Cal Prop 65 notification.

### **3.3 Microbial VOC Samples**

When the 31 microbial VOC samples were analyzed by EPA Method TO-15 SIM Modified Microbial Volatile Organic Compounds (TIC), only two MVOC were detected: 3-octanol and 2-hexanone (as known as methyl n-butyl ketone).

The 3-octanol appears only in one sample drawn from the 21st floor. It is classified as a FDA Part 172 -- Food Additives Permitted for Direct Addition to Food for Human Consumption, Subpart F--Flavoring Agents and Related Substances, Sec. 172.515 Synthetic flavoring substances and adjuvants.

- Sample # 21-4; 3-octanol was detected at a concentration of 9.6 ppbv.

In the case of the 2-hexanone, it appeared in concentrations above the limits of detection in the method blank. Also, 2-hexanone was reported in concentrations above the limits of detection in the following samples:

- Sample #21-1; 2-hexanone at 9.6 ppbv
- Sample #21-1; 2-hexanone at 0.34 ppbv
- Sample #2-3; 2-hexanone at 0.3 ppbv
- Sample #2-4; 2-hexanone at 0.17 ppbv
- Sample #21-5; 2-hexanone at 0.18 ppbv
- Sample #21-9; 2-hexanone at 0.86 ppbv
- Sample #21-12; 2-hexanone at 0.26 ppbv
- Sample #21-13; 2-hexanone at 0.38 ppbv
- Sample #21-14; 2-hexanone at 0.24 ppbv
- Sample #21-15; 2-hexanone at 0.18 ppbv

- Sample #2-15; 2-hexanone at 0.27 ppbv
- Sample #21-16; 2-hexanone at 0.47 ppbv

2-hexanone has an odor threshold of 0.076 ppm (OSHA) and 24 ppb (Nagata), and because of its odor, 2-hexanone can be detected below the National Institute for Safety and Health (NIOSH) recommended exposure limit (REL); thus, 2-hexanone is treated as a chemical with adequate warning properties.

#### 4.0 CONCLUSIONS AND RECOMMENDATIONS

1. In some spore trap samples, no airborne spores were detected. The spore trap samples collected from core sample locations 21-13, 21-14, and 21-16, showed elevated concentrations of *Penicillium/Aspergillus* (Pen/Asp) Type spores. However, VOC and microbial VOC detected at these same sample locations did not include 1-octen-3-ol (CAS 3394-86-4), which is an MVOC characteristic of Pen/Asp.
2. No VOC core building sampling results from November 4, 2011 exceeded the applicable California DOSH PELs.
3. All other interior core VOC concentrations were multiple orders of magnitude below the applicable occupational exposure limits (California DOSH PELs).
4. Two VOC (isobutyl alcohol and toluene) were found in core sample concentrations slightly above the AIHA's minimum odor thresholds of 12 ppb and 21 ppb for the two compounds, respectively.
5. No other VOC were detected above AIHA or Nagata odor threshold criteria.
6. Naphthalene's odor threshold is higher (AIHA minimum odor threshold: 9.5 ppb) than naphthalene concentrations detected in core samples #21-12 (3.09 ppb) and #21-13 (2.83 ppb). Naphthalene was, therefore, not found in detectable odor concentrations.
7. Several interior VOC concentrations were above the exterior ambient air sample concentrations. Some of the VOC detected indoors were not detected in the ambient exterior air.
8. Nineteen (19) VOC that are listed on OEHHA's Prop 65 list were detected in the building. Thirteen (13) of those VOC may exceed the threshold requiring Cal Prop 65 notification depending on duration of exposure and the location/access of the core samples. All of the core samples in this investigation were collected in locations inaccessible to personnel. Additional information/data on VOC concentrations in the building (collected historically) should be evaluated to determine the applicability of the Cal Prop 65 notification. The building already has a posted Prop 65 notification unrelated to this sampling event.
9. Only two (2) MVOC appear in the data: 2-hexanone and 3-octanol. In the case of the 2-hexanone, the compound also appears in the method blank and at a higher concentration than in the single sample it is detected in. The 3-octanol appears only in one sample drawn from



the 21st floor. It is classified as a FDA Part 172 -- Food Additives Permitted for Direct Addition to Food for Human Consumption, Subpart F--Flavoring Agents and Related Substances, Sec. 172.515 Synthetic flavoring substances and adjuvants.

10. DGS has elected to continue to monitor the indoor air quality (limited VOC and fungal genus and species) of the building tenant spaces until such time as results of air monitoring indicate conditions in the building require additional action on the part of the property management and owner.
11. The findings and recommendations of this report should be communicated to affected employees.

## **5.0 LIMITATIONS AND QUALIFICATIONS**

The assessment performed by LCD does not include or cover the following matters: Matters that are subsequently discovered that could not have been reasonably foreseen or detected, using industry standards, during the performance of the assessment; matters that could not have been discovered by LCD because of barriers, lack of access or other matters affecting accessibility; matters that are not disclosed to LCD prior to, during, or after the performance of the assessment; and any new deficiency that may arise after the completion of the assessment by LCD.

To the extent that additional information becomes available to LCD, LCD reserves the right (without any obligation to do so) to modify its evaluation and/or this Report at any time, based upon further review and analysis of any such additional information or data.

Certain items mentioned in the Report were performed by others not involving the supervision of, or management by, LCD, but were relied upon by LCD in making its evaluation and assessment.

The assessment performed by LCD is not meant or intended to supplement, modify, or extinguish any warranty or representation made or given by third parties performing any of the recommended corrective work.

When consultation involves microbiological growth, or any assessment thereof, such microbiological growth may reoccur if the source of the growth is not remedied. All remediation of fungi in indoor environments can be inherently limited in the sense that conclusions are drawn and recommendations developed from information obtained from limited research and site evaluation. Except as may be noted in the assessment performed by LCD, subsurface areas, latent defects, or non-accessible areas and conditions were not field investigated and may differ from the conditions implied by the surface observations. Additionally, the passage of time may result in a change in the environmental characteristics at the subject property and the surrounding properties. No investigation or assessment can absolutely rule out the existence of any microbiological growth at any given site. LCD does not remediate or remedy sources of microbiological growth.

This Report and the assessment/survey conducted by LCD is prepared, and was performed, solely for the use and benefit of the client identified at the beginning of this Report. No other party may rely on this Report for any other purpose.

Report prepared by,

A handwritten signature in black ink, appearing to read "Ben Heckman".

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Chris Corpuz, MS, CIH  
Senior Manager

## **FIGURES**

**Figure 1     Sample Port Locations – Floor 2**

**Figure 2     Sample Port Locations – Floor 21**

**LEGEND**

02-6 Sample Port Location

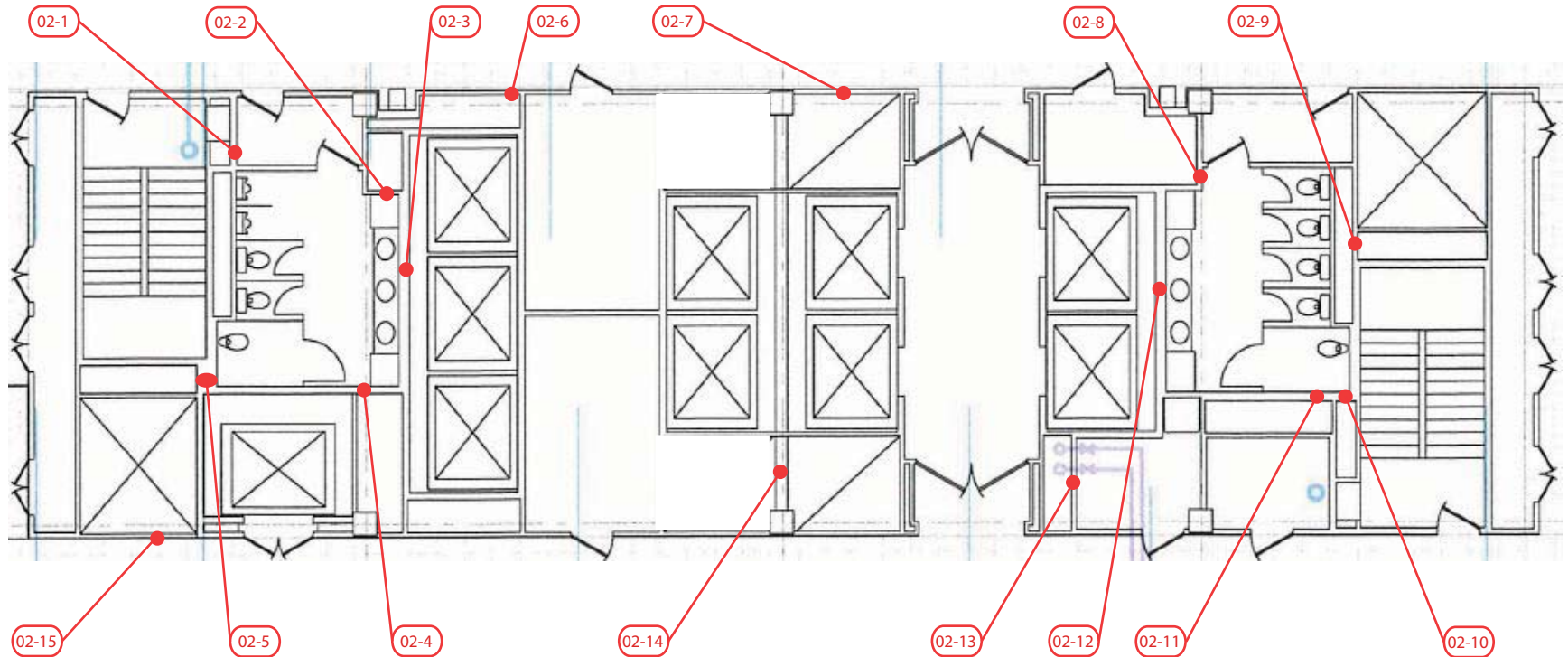


Image Not to Scale

Sample ports 1 - 5 are accessible through the men's bathroom ceiling access panel.  
Sample port 6 is accessible through the janitor closet ceiling access panel.  
Sample ports 8 - 12 are accessible through the women's bathroom ceiling access panel.  
Sample ports 7 and 13 - 15 are accessible by removal of ceiling tiles in corridor.

## LEGEND

21-6 Sample Port Location

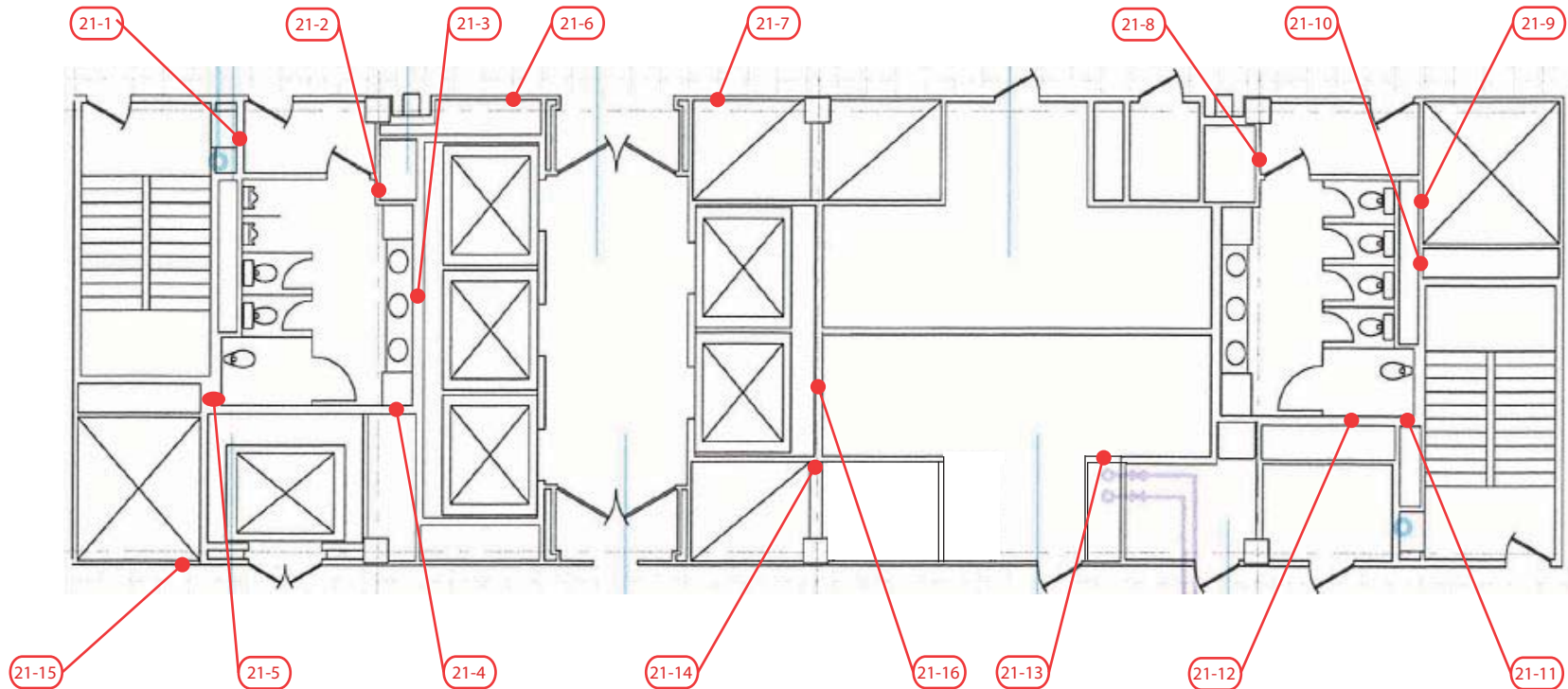


Image Not to Scale

Sample ports 1 - 5 are accessible through the men's bathroom ceiling access panel.  
Sample ports 6, 7 and 15 are accessible by removal of ceiling tiles in corridor.  
Sample ports 8 - 12 are accessible through the women's bathroom ceiling access panel.  
Sample ports 13, 14 and 16 are accessible through the mailroom ceiling access panel.

## TABLES

**Table 1      VOC Sample Result Summary**

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